Department of Pesticide Regulation

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SUBJECT: RECOMMENDATION FOR PRIORITY SURFACE WATER MONITORING STUDIES ON SELECTED PESTICIDES

ABSTRACT

This memorandum documents the procedure used to screen candidate pesticides for priority surface water monitoring in fiscal year 2000-2001. An analysis of the two databases containing pesticide use data (Pesticide Use Report or PUR) and surface water sampling data (SURF) was conducted by comparing the pesticide use location and rate with the location and intensity of past surface water sampling activities. Pesticides with extensive use, but with no or only limited sampling data were identified and were further evaluated against a number of other factors such as chemical properties, timing of application, local and regional hydrologic conditions, and aquatic toxicity. The screening procedure categorized pesticides of concern into five action groups: No Action, Rice Herbicide Program, Priority Monitoring, Secondary Priority Monitoring, and Mitigation. The Priority Monitoring group consisted of three pesticides, maneb, oryzalin, and chlorothalonil, that were considered undermonitored in past surface water monitoring activities, but possess a high potential of contaminating surface water given their historical use practice and chemical properties. Additional monitoring of these pesticides is recommended to further characterize their spatial and temporal distribution and trends in susceptible surface water bodies. The respective sampling protocols will be developed and presented in a separate report.

INTRODUCTION

Despite the substantial monitoring efforts that were devoted to the assessment of surface water quality in the past decade, there is still a lack of comprehensive appreciation of surface water conditions with respect to pesticide contamination in California. A primary factor contributing to

this lack of understanding is the large number of pesticide active ingredients (AIs) that were discharged in the state each year. Based on the Pesticide Use Report (PUR), around 800 to 900 pesticide AIs, totaling approximately 2.0×10^8 lbs, are applied in California each year from agricultural use alone. Characterization of such a large number of pesticides in surface water is practically impossible, thus a screening methodology must be exercised to prioritize monitoring efforts.

Previous pesticide monitoring studies in surface water were primarily carried out by the California Department of Pesticide Regulation, Environmental Hazard Assessment Program (EHAP), United States Geological Survey (USGS), and the Central Valley Regional Water Quality Control Board. Data from these and other studies are documented in EHAP's surface water database (SURF). At present, SURF contains more than 93000 pesticide analysis records for 146 chemicals. Table 1 summarizes for each pesticide the number of analyses, frequency of detection, the 95^{th}, 75^{th}, and 50^{th} percentile concentration, soil sorption and dissipation data, and use information (lbs of use and rank) for the period of 1990 to 1998. Eighty-nine pesticides or degradation products have been detected in California surface waters. The most extensively monitored pesticides were diazinon (number of analysis=5642), chlorpyrifos (number of analysis=4397), malathion (number of analysis=3415), carbofuran (number of analysis=3328), and methidathion (number of analysis=3151). There is a wide range in sampling frequency among different pesticides. The sampling frequency for each pesticide, however, does not necessarily reflect the potential of the pesticide to runoff to surface water. The purpose of this memorandum is to identify those pesticides that have a high probability of occurrence in surface water, but with only limited historical monitoring data. It is hoped that by prioritizing future monitoring efforts on these pesticides, our monitoring program would become more effective in developing an understanding of the status of pesticide contamination in surface water, thereby providing a basis for regulatory decisions.

METHODOLOGY

SURF and PUR are the most comprehensive compilation of surface water pesticide monitoring and pesticide use in California. Both of the databases have been developed by the Department of Pesticide Regulation (DPR). SURF contains surface water monitoring data collected by nine different agencies over the period of 1990 to 2000, and is being updated on a continuous basis as data becomes available. The Pesticide Use Report contains pesticide use records mainly from agricultural activities. The information entered into PUR details each pesticide application event, including product use rate, application date, crops being treated, and acreages, etc. PUR was updated yearly and was published as separate reports for individual years.

An evaluation of SURF and PUR was conducted by overlaying both the monitoring and use data as classed post maps using the program Surfer (Golden Software, Inc., version 7.0). The monitoring data, represented by the total number of analyses recorded for each AI in SURF, was superimposed on the same map with the total amount of that pesticide in PUR at the section scale (one square mile). The graphic analysis of SURF and PUR was performed for each pesticide AI that had a use rank of 50 or above based on the cumulative amount applied during the years of 1990-1998, except for those which (1) may occur naturally (such as mineral oil, petroleum oil, sulfur, etc.) so that it is impossible to discern sources of contamination, (2) are highly volatile that surface water concentration would dissipate quickly, or (3) are applied as adjuvant. In addition, the graphic analysis was augmented to also include those which had a use rank below 50, but a detection frequency (df) of ≥10% based on the existing monitoring data.

The purpose of superimposing the use and monitoring data is to provide a visual comparison between the locations of pesticide application and those of sampling activities. Monitoring results from sampling events distant from application sites provides little or no information on potential for off-site movement. Comparison of use and sampling data allows a direct evaluation of the representativeness and adequacy of historical sampling activities. Our goal is to identify those pesticides for which further data are needed. Once such a pesticide was identified from inspection of the maps generated from Surfer, a number of other factors were then considered. These factors include the chemical properties of the pesticide, the temporal use pattern, local and regional hydrologic conditions, and pesticide toxicity.

The primary chemical properties that influence runoff potential are pesticide sorptivity and persistence. In general, chemicals with lower sorption and longer persistence are more likely to move off-site into surface water. However, several other factors also affect, or may even dominate, the potential of a pesticide to move into surface water by runoff. For example, the application timing relative to the occurrence of rainfall events can have a substantial influence on subsequent pesticide runoff. In most of California's agricultural areas, about 80% of precipitation occurs during the months between late October and early April. Pesticides applied during these months are therefore more susceptible to runoff compared to other periods of the year. The effects of chemical properties, application timing, and other site-specific variables, however, are difficult to assess in a quantitative manner without extensive modeling analyses. Unless detailed modeling is carried out which would require substantial site-specific information across the state, the uncertainty of any modeling exercise built upon a simplified or standardized scenario would in the end outweigh the potential benefit. Since we intend to initiate monitoring studies before the upcoming rainy season of this year, the stringent timeframe prohibits any significant modeling attempts. For these reasons, although considerations were given to the chemical properties, use pattern, and other factors, no effort was made to develop a numerical scale to factor quantitatively these characteristics into the final selection.

RECOMMENDATIONS

A total of 29 AIs were evaluated in this screening analysis, representing those of most concern for surface water contamination. The Surfer post maps showing the historical use and sampling data for these pesticides are presented in Figure 1 to 29. Also shown on the Figures is the monthly use pattern of the pesticides summed over 1990 to 1998. Based on these data, the pesticides were classified into five action groups. Table 2 provides a summary of the recommended actions, pesticides under each action group, and justification. For easy reference, key statistics characterizing use and sampling data are also provided.

The five recommended action groups are:

1. No Action:

Carbaryl
Cynazine
Dimethoate
Ethephon
Malathion
s,s,s-Tributyl phosphorotrithioate
Trifluralin

2. Rice Herbicide Program:

Molinate
Thiobencarb

3. Priority Monitoring:

Chlorothalonil
Maneb
Oryzalin

4. Secondary Priority Monitoring:

2,4-D
Captan
Dicofol

Iprodione
Mancozeb
Paraquat dichloride
Propyzime
Propargite
Ziram

5. Mitigation:

Chlorpyrifos
Chlorthal-dimethyl
Diazinon
Diuron
EPTC
Methomy
Metolachlor
Simazine

In general, the No Action group includes pesticides that were extensively monitored with a low detection frequency. The Rice Herbicide Program is an on-going program since 1990. It monitors surface water quality for rice herbicides and subsequently enforces use restrictions. As such no additional monitoring is currently needed for rice herbicides. The Priority Monitoring group includes pesticides that are extensively used, but with no or only limited surface water sampling data. Meanwhile, the chemical properties of these pesticides indicate a medium to high potential for runoff, and they are highly toxic to fish and other aquatic organisms. The Secondary Priority Monitoring group is intended as backup monitoring pesticides in case that any technical or other difficulties would prevent monitoring of pesticides in the Priority Monitoring group. Pesticides in the Secondary Priority Monitoring group have either a lower rank of use, a lower potential for runoff, or a lower aquatic toxicity. Finally the Mitigation group includes pesticides that were extensively monitored and demonstrate a high detection frequency. These are known surface water pollutants and therefore mitigation studies are recommended. Table 2 provides more specific justifications for each pesticide.

LIMITATIONS

A major limitation of our analysis, hence the recommendation derived from it, is that the database we used for pesticide use (PUR) is incomplete. Many pesticide uses for nonagricultural purposes such as home uses, rights of way applications, and golf course treatments were not included in the database. Nevertheless, the proposed monitoring studies will complement effectively the previous monitoring activities.

Table 1. Summary of historical surface water sampling data as of July, 2000
Source: SURF, Department of Pesticide Regulation

Chemical code	Pesticide	# of analyses	# of detection	Detection frequency,%	Concentration, ppb (percentile or range)[a]			Chemical property [b]			Use (1990-1998)	
					95th	75th	50th	K_{oc}, mL/g	$t_{1/2}$, day	Solubility, ppm	Sum, lbs	Rank
231	diuron	612	350	57.2	3.6	0.719	0.281	477	90	42	10742373	23
531	simazine	2163	976	45.1	0.844	0.245	0.12	140	89	6.2	8343990	25
198	diazinon	5642	2469	43.8	0.82	0.161	0.053	1520	32	60	10748153	22
253	chlorpyrifos	4397	1211	27.5	0.324	0.051	0.02	9930	43	1.18	24439119	10
1996	metolachlor	1060	237	22.4	0.17	0.052	0.018	70	141	488	1740346	84
449	molinate	1934	432	22.3	19.98	6.3	0.38	117	13	970	12178787	20
179	chlorthal-dimethyl (DCPA)	1000	205	20.5	0.15	0.014	0.007	5600	50	0.5	5347859	42
383	methomyl	1017	191	18.8	0.76	0.27	0.15	36	28	58000	6801558	34
4047	endosulfan sulfate	661	114	17.2	0.141	0.0658	0.025					
786	mcpa, dimethylamine salt	202	32	15.8	1.63	0.45	0.19	110	25	825	2320652	77
264	eptc	1098	171	15.6	0.5	0.055	0.016	223	18	375	6181261	38
2131	triclopyr	163	22	13.5	7.69	2.99	0.64	68	35	435	228981	210
694	propyzamide	354	47	13.3	0.068	0.02	0.018	750	45	12.9	1071147	112
1640	cyanazine	1125	132	11.7	0.564	0.219	0.11	218	13	155	4038833	48
636	2,4-D	427	49	11.5	1.39	0.4	0.16	48	14	23180	202056	216
1933	thiobencarb	1900	214	11.3	6.96	2.04	0.8	900	19	28	3879809	51
445	propargite	330	32	9.7	2	0.039	0.022	13895	84	0.6	15856282	15
4062	dcpa acid metabolites	217	21	9.7	0.017	0.013	0.007					
106	carbofuran	3328	314	9.4	0.94	0.366	0.094	46	41	350	2534612	72
216	dimethoate	1153	104	9.0	1.05	0.213	0.12	20	7	39800	6075957	39
4051	deethyl-atrazine	334	27	8.1	0.043	0.012	0.005					
1728	napropamide	1075	85	7.9	0.11	0.042	0.024	462	48	74	1692212	85
1929	pendimethalin	443	35	7.9	0.24	0.155	0.055	13400	174	0.275	3357496	58
499	prometon	790	56	7.1	0.32	0.126	0.085	95	1300	720	1573	607
5743	2,6-diethylaniline	142	10	7.0		0.001 - 0.007						
2166	ethalfluralin	331	23	6.9	0.098	0.051	0.034	5120	41	0.3	439035	169
2092	dde	960	66	6.9	0.03	0.012	0.008	381000	>72(	0.065		
1689	methidathion	3151	212	6.7	1.102	0.161	0.069	400	7	240	3039826	64
597	trifluralin	1818	119	6.5	0.057	0.02	0.011	7200	81	0.32	11893842	21
1810	tebuthiuron	461	28	6.1	0.17	0.07	0.039	130	360	2400	39902	346
105	carbaryl	2744	150	5.5	1.7	0.31	0.1	288	14	110	7229167	30
4046	endosulfan II	764	41	5.4	0.066	0.0377	0.023					
259	endosulfan	764	40	5.2	0.105	0.049	0.024	12400	60	0.32	2938849	66
503	propanil	348	18	5.2	5.3	2.53	1.28	400	6	152	967494	120

Table 1. Summary of historical surface water sampling data as of July, 2000 (Continued)
Source: SURF, Department of Pesticide Regulation

Chemical code	Pesticide	# of analyses	# of detection	Detection frequency,%	Concentration, ppb (percentile or range)[a] 95th	75th	50th	Chemical property [b] K_{oc}, mL/g	$t_{1/2}$, day	Solubility, ppm	Use (1990-1998) Sum, lbs	Rank
361	linuron	426	21	4.9	0.56	0.34	0.28	496	82	75	957560	122
45	atrazine	1990	97	4.9	0.14	0.033	0.02	147	64	33	444711	166
437	naptalam, sodium salt	21	1	4.8		0.06 - 0.06		2212	20	> 200	15460	415
83	bromacil	683	28	4.1	1.32	0.126	0.088	13	120	700	977805	118
1944	bentazon, sodium salt	221	9	4.1		0.07 - 0.13		35	27	> 200	10101	452
210	dieldrin	480	19	4.0	0.018	0.013	0.009	12000	>225	0.25		
53	benefin	330	13	3.9		0.007 - 0.014		8240	80	0.1	558819	147
459	ethyl parathion	1491	56	3.8	0.51	0.12	0.003				1506467	94
367	malathion	3415	127	3.7	0.86	0.2	0.062	1200	9	130	8145912	27
590	pebulate	1054	37	3.5	0.471	0.057	0.017	430	8	100	2172889	79
641	mcpb,sodium salt	220	7	3.2		0.08 - 0.94		540	10	44	104	801
502	prometryn	366	11	3.0	0.336	0.203	0.132	383	76	33	1929661	82
254	fonofos	2604	76	2.9	0.26	0.065	0.03	1920	37	13	557902	148
1692	metribuzin	701	19	2.7	0.052	0.024	0.013	52	47	1000	280775	196
678	alachlor	1058	28	2.6	0.081	0.026	0.012	124	27	240	540558	149
1868	oryzalin	199	5	2.5		0.08 - 1.51		600	42	2.5	6453342	36
314	azinphos-methyl	1188	25	2.1	0.28	0.099	0.056				3825122	53
392	methyl isothiocyanate	48	1	2.1		56.6 - 56.6					32245	363
1552	benomyl	96	2	2.1		1.9 - 3.2		2100	80	2.9	1998304	81
2503	dichlorprop	153	3	2.0		0.04 - 0.11		170	10	350		
5020	2,4-DB	220	4	1.8		0.22 - 1.08		20	7	46	8629	466
1871	hexazinone	366	6	1.6		0.253 - 0.581		41	79	29800	1101560	109
339	propham	315	5	1.6		3.6 - 19.9		98	10	250	2688	567
2006	sulprofos	128	2	1.6		1.0 - 1.0		25900	18	0.31	27338	373
2019	norflurazon	150	2	1.3		0.06 - 0.44		353	163	34	1685759	86
565	butylate	910	11	1.2		0.002 - 0.01		304	28	44	790670	133
478	phorate	844	8	0.9		0.016 - 0.22		1057	37	50	1507671	93
566	demeton	116	1	0.9		0.18 - 0.18		> 7	8 - 2	> 60	18844	408
1910	oxamyl	1087	9	0.8		0.05 - 0.27		9	13	280000	796815	132
639	2,4,5-t	370	3	0.8		0.11 - 0.78		110	30	150		
394	methyl parathion	2132	16	0.8		0.187 - 0.112					1196968	101
90359	bhc (other than gamma isomer)	284	2	0.7		0.002 - 0.002						
92008	permethrin, other related	142	1	0.7		0.013 - 0.013					0	1094

Table 1. Summary of historical surface water sampling data as of July, 2000 (Continued)
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4064	diazoxon	773	5	0.6		0.06 - 0.43						
190	s,s,s-tributyl	328	2	0.6		0.01 - 0.01		7700	32	23	7237154	29
200	dicamba	332	2	0.6		0.1 - 1.8		13	16	8310	2462	579
532	terbacil	335	2	0.6		0.008 - 0.034		63	204	710	322	714
268	ethion	388	2	0.5		0.01 - 0.05		10000	56	1.1	42620	340
834	bromoxynil	222	1	0.5		0.06 - 0.06					1130770	106
2194	isofenphos	248	1	0.4		0.07 - 0.07		777	103	18	0	1164
4074	3-hydroxyca	840	3	0.4		0.06 - 0.18						
166	fluometuron	315	1	0.3		3		100	95	110	10824	442
49	triallate	330	1	0.3		0.003		2550	74	4	11889	436
2925	terbufos	335	1	0.3		0.04 - 0.04		650	12	4.5		
511	propachlor	425	1	0.2		0.002 - 0.002		265	9	613		
230	disulfoton	860	2	0.2		0.06 - 0.06		1345	37	12	1333170	96
359	lindane (gan	480	1	0.2		0.005 - 0.005		1355	423	7	69924	298
2265	aldicarb sulf	993	2	0.2		0.05 - 0.258						
375	methiocarb	1096	2	0.2		0.06 - 0.08		585	12	24	41443	342
335	phosmet	1147	2	0.2		0.3 - 0.63		668	14	20	3139591	62
4077	methiocarb s	626	1	0.2		0.11 - 0.11						
4076	malaoxon	635	1	0.2		0.06 - 0.06						
404	ethoprop	813	1	0.1		0.003 - 0.003		104	29	843	401440	174
2361	aldicarb sulf	993	1	0.1		0.28 - 0.28						
575	aldicarb	1018	1	0.1		0.12 - 0.12		26	50	5900	3325498	59
9	aldrin	150	0	0				17500	365	0.027	4	997
55	barban	95	0	0				> 1160	8	11	3854	539
62	propoxur	461	0	0				29	> 28	1800	25859	379
63	fenthion	128	0	0				1390	34	4.2	5337	508
110	carbophenot	248	0	0				50000	30	0.63	2322	584
112	dichlobenil	75	0	0				171	55	18	26933	375
130	chlordane	150	0	0				60000	456	0.056	1172	625
141	chlorpropha	95	0	0				505	30	89	28795	369
165	coumaphos	128	0	0						1.5	0	1068
181	fensulfothio	128	0	0				300	30	1540	30	883

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Source: SURF, Department of Pesticide Regulation

Chemical code	Pesticide	# of analyses	# of detection	Detection frequency,%	Concentration, ppb (percentile or range)[a] 95th	75th	50th	Chemical property[b] K_{oc}, mL/g	$t_{1/2}$, day	Solubility, ppm	Use (1990-1998) Sum, lbs	Rank
184	ddd	150	0	0				231000	> 720	0.05		
186	ddt	300	0	0				426580	> 720	0.04		
187	ddvp (dichlc	708	0	0				50	< 1	8000	70867	296
226	diphenamid	128	0	0							9923	455
238	dinoseb	302	0	0				30	30	52	14481	424
262	endrin	150	0	0							13	931
293	merphos	193	0	0							102419	257
317	heptachlor	150	0	0				24000	250	0.056	27	890
382	oxydemeton	150	0	0					5	1000000	1092655	110
408	monuron	95	0	0				150	170	230	1287	621
418	naled	128	0	0				157	< 1	1.5	3413317	57
424	neburon	315	0	0				2500	130	4.8	19	917
479	phosalone	708	0	0				1816	26	3.05	19228	405
480	mevinphos	124	0	0				44	2	600000	884682	124
487	piperonyl cy	146	0	0								
517	ronnel	128	0	0							20	916
530	silvex	370	0	0								
533	dnoc, sodiur	74	0	0							36	871
576	chloroxuron	95	0	0				2820	45	2.5	32968	361
593	picloram	199	0	0				29	108	> 430	1134	627
594	toxaphene	150	0	0				100000		3	5127	511
603	siduron	95	0	0				420	128	1800	2795	561
623	mexacarbate	95	0	0				300	10	1000	224	745
677	chlorothalor	75	0	0				5000	48	0.6	8266122	26
2008	permethrin	188	0	0				39300	42	0.006	2811393	67
2184	chloramben	221	0	0				21	14	700	827	654
2218	acifluorfen,	221	0	0							70	829
2321	esfenvalerat	64	0	0				5273	42	0.0002	402659	173
2326	MCPA	78	0	0				110	25	825		
2349	acetochlor	258	0	0								
2435	aminocarb	95	0	0				100	6	915		
3531	methyl trithi	128	0	0								
4054	azinphos-me	580	0	0								

Table 1. Summary of historical surface water sampling data as of July, 2000 (Continued)
Source: SURF, Department of Pesticide Regulation

Chemical code	Pesticide	# of analyses	# of detection	Detection frequency,%	Concentration, ppb (percentile or range)[a] 95th	75th	50th	Chemical property[b] K_{oc}, mL/g	$t_{1/2}$, day	Solubility, ppm	Use (1990-1 Sum, lbs
4069	endrin aldeh	150	0	0							
4072	fenuron	315	0	0				42		60	
4073	heptachlor e	150	0	0							
4078	methiocarb s	626	0	0							
4082	ethyl parathi	410	0	0							
4083	methyl para	580	0	0							
4089	phosmet-oa	635	0	0							
5001	trichloronate	128	0	0				400		139	
5034	chlorpyrifos	635	0	0							
5040	methidathio	740	0	0							
5041	phosalone O	517	0	0							
5135	clopyralid	221	0	0				36		13	

[a] Values are to the closest percentile possible, and for the detected concentrations only.

[b] Sources for chemical property values are: (1) Pesticide properties database, USDA Remote Sensing and Mmodeling Laboratory; and (2) Pesticide Information Profiles, EXTONET, University of California at Davis, Oregon University, Michigan State University, Cornell University, and the University of Idaho;
$t_{1/2}$: half life of field disspation.

Table 2. Recommended actions for pesticides of concern for surface water contamination

Recommended action	Pesticide	Rank of use (1990-1998)	Sampling history[a] # of analyses	df, %	Justification
No Action	Carbaryl	30	2744	5.5	Extensively monitored with a low df
	Cyanazine	48	1125	11.7	Registration cancelled
	Dimethoate	39	1153	9.0	Extensively monitored with an intermediate df, but 95th percentile concentration (1.05 ppb) well below the Water Quality criterion (63 ppb, DFG, 1996)[b]
	Ethephon	28	0		Extensively used, but only slightly toxic to fish, breakdown rapidly in soil ($t_{1/2}$=15 day, Table 1)
	Malathion	27	3415	3.7	Extensively monitored with a low df
	s,s,s-Tributyl phosphorotrithioate	29	328	0.6	Limited sampling data, but use area mainly in the hydrologically closed Tulare basin (Figure 15)
	Trifluralin	21	1818	6.5	Extensively monitored with a low detection frequency and a low 95th percentile concentration (0.057 ppb, Table 1)
Rice Herbicide Program	Molinate	20	1934	22.3	Rice herbicide
	Thiobencarb	50	1900	11.3	Rice herbicide
Priority Monitoring	Chlorothalonil	26	74	0	Extensively used, but with little sampling data (Figure 3), chemical properties indicating a medium potential of runoff (K_{oc}=4000 cm^3/g, $t_{1/2}$=48 day, Table 1), highly toxic to fish and other aquatic species

Table 2. Recommended actions for pesticides of concern for surface water contamination (continued)

Recommended action	Pesticide	Rank of use (1990-1998)	Sampling history[a] # of analyses	Sampling history[a] df, %	Justification
Priority Monitoring	Maneb	24	0		Extensively used, but with no sampling data, chemical properties indicating a high potential of runoff (K_{oc}=240 cm^3/g, $t_{1/2}$=30 day, Table 1), highly toxic to fish and other aquatic species
	Oryzalin	36	199	2.5	Extensively used, but with limited sampling data (Figure 12), used mostly during the raining season, chemical properties indicating a high potential of runoff (K_{oc}=600 cm^3/g, $t_{1/2}$=42 day, Table 1), highly toxic to fish
Secondary Priority Monitoring	2,4-D	216	427	11.5	Limited sampling data, with a medium df and a low rank of use
	Captan	40	0		Extensively used with no sampling data, but chemical properties indicating a low potential for runoff ($t_{1/2}$=5 day, Table 1)
	Docofol	41	0		Extensively used with no sampling data, but chemical properties indicating a low potential for runoff (K_{oc}=6064 cm^3/g, Table 1)
	Iprodione	46	0		Extensively used with no sampling data, but only moderately toxic to fish
	Mancozeb	45	0		Extensively used with no sampling data, but only moderately toxic to fish
	Paraquat dichloride	33	0		Extensively used with no sampling data, but only slightly toxic to fish
	Propargite	15	330	9.7	Extensively used with limited sampling data (Figure 13), but applied mainly in the summer season with low precipitation, and chemical properties indicating a low potential of runoff (K_{oc}=13895 cm^3/g, Table 1),

Table 2. Recommended actions for pesticides of concern for surface water contamination (continued)

Recommended action	Pesticide	Rank of use (1990-1998)	Sampling history[a] # of analyses	Sampling history[a] df, %	Justification
Secondary Priority Monitoring	Propyzamide	112	354	13.3	Limited sampling data, with a medium df and a low rank of use
	Ziram	18	0		Extensively used with no sampling data, but moderate toxic to fish
Mitigation	Chlorpyrifos	10	4397	27.5	Extensively monitored with a high df
	Chlorthal-dimethyl	42	1000	20.5	Extensively monitored with a high df
	Diazinon	22	5642	43.8	Extensively monitored with a high df
	Diuron	23	612	57.2	Limited sampling data, but with an extremely high df
	EPTC	38	1098	15.6	Extensively monitored with a relatively high df
	Metolachlor	84	1060	22.4	Extensively monitored with a high df
	Methomyl	34	1017	18.8	Extensively monitored with a high df
	Simazine	25	976	45.1	Extensively monitored with a high df

a. df: Detection frequency.
b. California Department of Fish and Game, 1996, Recommended Water Quality Criteria, Hazard Assessment Program.